Space Weather Technical Forecast

Issued on Tuesday, 07 March 2023 at 12:26 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: M-class flares (R1-R2/Minor-Moderate radio blackouts) likely throughout. Slight chance of G1/Minor Storm intervals 07-09 March. Electron fluence is expected to be Active.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Moderate in the last 24 hours with one low level M-class flare from AR3242 near north centre disc, which is one of the largest regions on the disc. It has a delta region in one of its intermediate spots, but otherwise does not appear to be significantly complex. Another region of interest is AR3245 in the southeast, which has continued to grow with the leading and trailing spot penumbra starting to merge to form a delta region. AR3243, which was the source of two M5 flares on the 05 and 06 March, is now near the west limb and difficult to assess. There are now twelve sunspot regions on the visible disc, but the remaining regions are all relatively simple or evolving slowly.
No Earth directed CMEs were observed in available imagery during the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind as observed by DSCOVR and ACE at L1, has been indicative of a continuing High Speed Stream (HSS) from CH81. Wind speeds were at elevated to strong levels, varying between 530-700 km/s. Density has been around average throughout. Total IMF, Bt, was weak below 6nT, with the north-south component, Bz, varying weakly between +/-5nT. Phi angle was primarily negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp 2 to 3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16 remained at background levels. Electron flux at GOES16 has been mostly high with a peak of 3790pfu at 06/1615 UTC. Electron fluence has been above the Active threshold (1e8 integrated flux) throughout, with a value of 1.63e8 integrated pfu recorded at 07/0000UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is forecast to be mainly Low to Moderate, with a slight chance of Strong activity. The main risk of flares is from AR3242, AR3245, with a declining risk from AR3243.

Solar Wind / Geomagnetic Activity: There is one possible glancing CME currently forecast on 07 or 08 March, but with low confidence. Earth is experiencing strong solar wind speeds under the influence of a HSS from the large coronal hole 81. The HSS is expected to start to wane through Days 1 and 2 (07-08 Mar), but elevated wind speeds are likely to be prolonged by the smaller coronal hole 82 which could connect on Days 2 or 3 (08-09 Mar). As the Earth is approaching the March equinox, negative polarity coronal holes such as 81 and 82 are favoured for providing a slightly stronger geomagnetic response.
Geomagnetic activity is expected to be Quiet to Unsettled throughout the period, with a declining risk of Active or G1/Minor Storm intervals, mainly due to any glancing CME effects or the onset of coronal hole 82.

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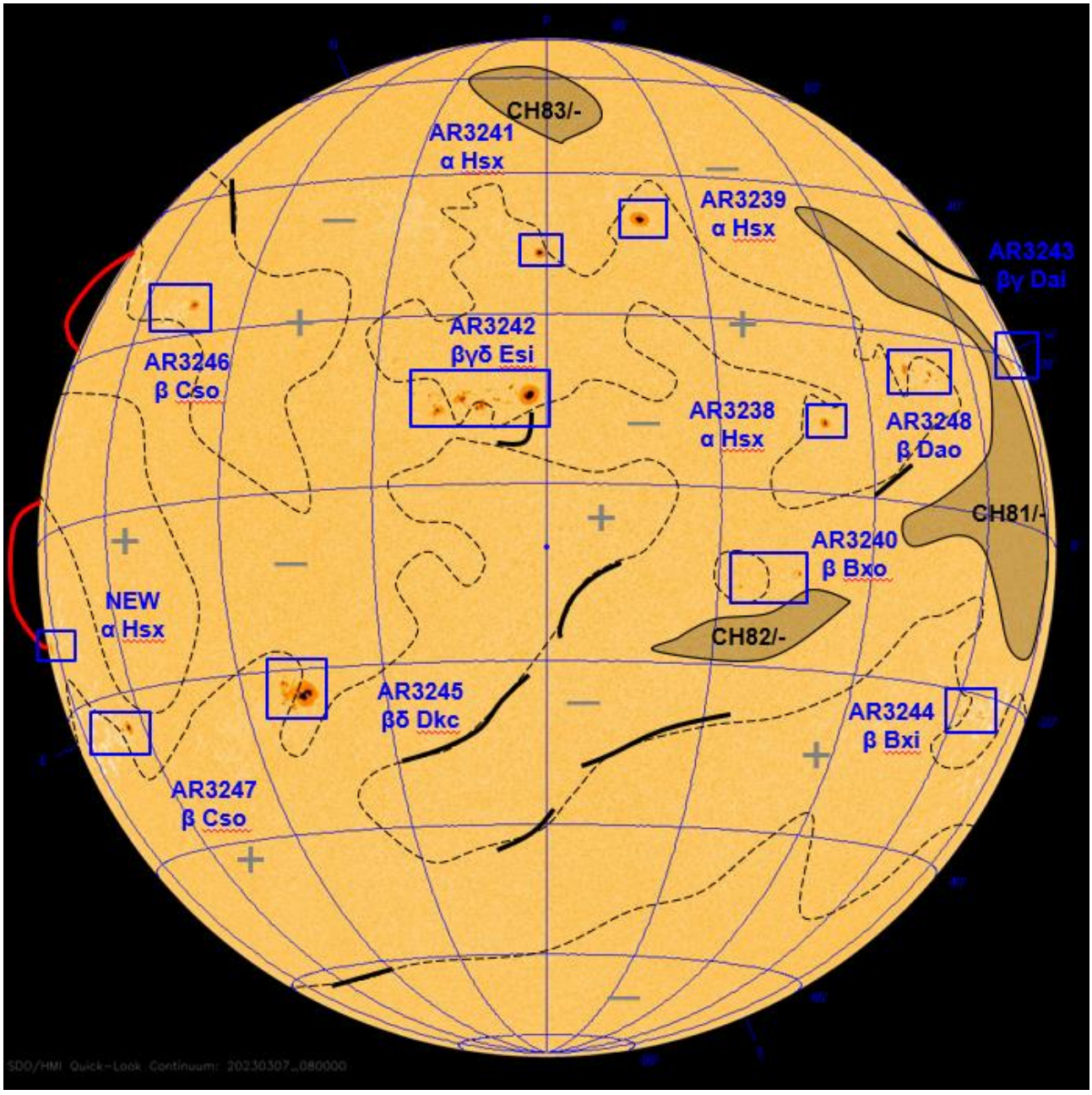
Met Office Space Weather Technical Forecast

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux, as observed by GOES16, is currently at background levels but with a slight chance of reaching S1 or greater should any larger flares occur. Electron flux is likely to continue at high levels but with uncertainty due to the risk of a CME glancing blow and a further HSS potentially suppressing levels. Electron fluence is above the Active (1e8 integrated pfu) threshold and is likely to remain so through the period, albeit with some uncertainty.

Figure 1. Solar Analysis Valid 07/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There is one possible glancing CME currently forecast, but with low confidence. This was a CME which left the Sun on 05 Mar, which could just glance the Earth on either 07 or 08 Mar, however it is more likely to miss ahead of the Earth orbit.

Earth is experiencing strong solar wind speeds under the influence of a HSS from the large coronal hole 81 which is now close to the western limb. The HSS is expected to start to wane through Days 1 and 2 (07-08 Mar), but elevated wind speeds are likely to be prolonged by the smaller coronal hole 82 which is now west of centre disc and could connect on Days 2 or 3 (08-09 Mar). As the Earth is approaching the March equinox, negative polarity coronal holes such as 81 and 82 are favoured for providing a slightly stronger geomagnetic response.

Geomagnetic activity is expected to be Quiet to Unsettled throughout the period, with a declining risk of Active or G1/Minor Storm intervals, mainly due to any glancing CME effects or the onset of coronal hole 82.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	20	20	10	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
*	*	*	*	*	*	*

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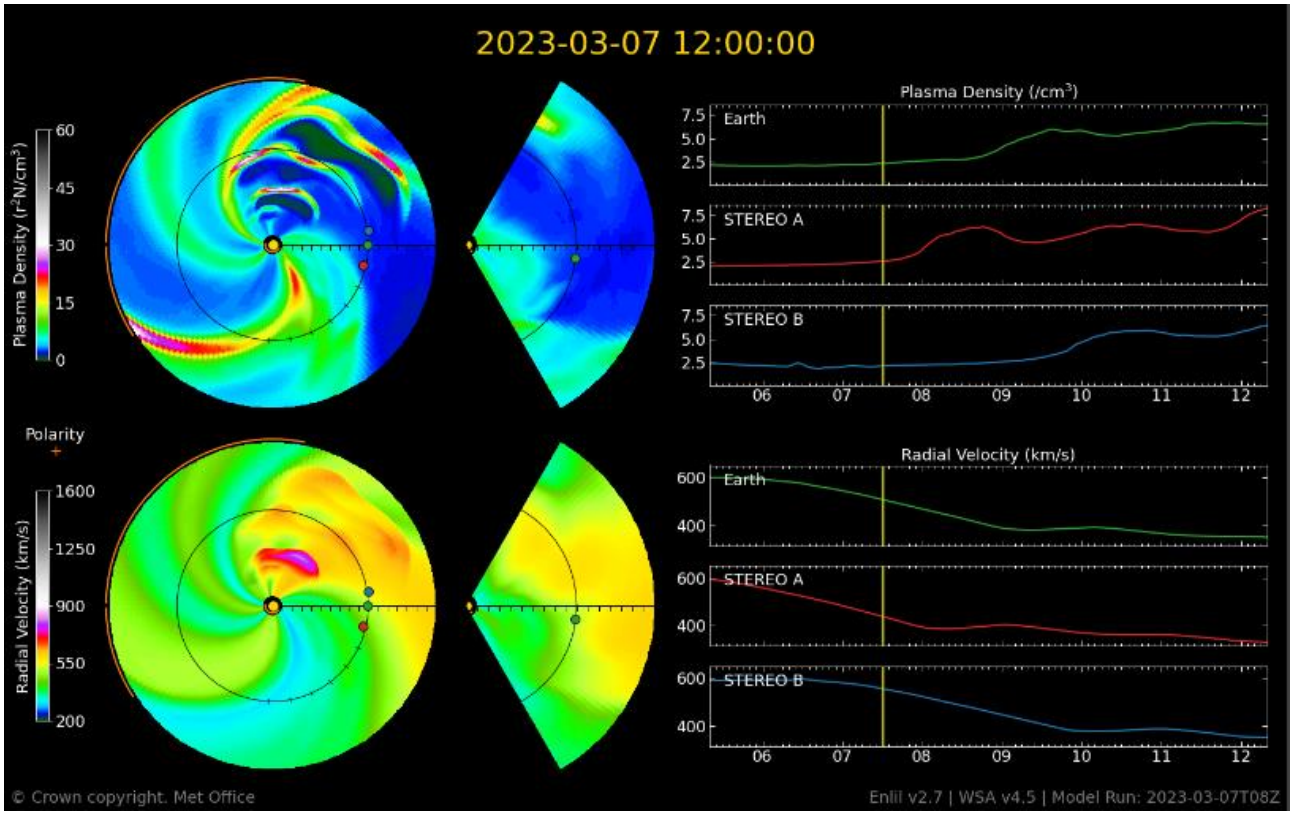
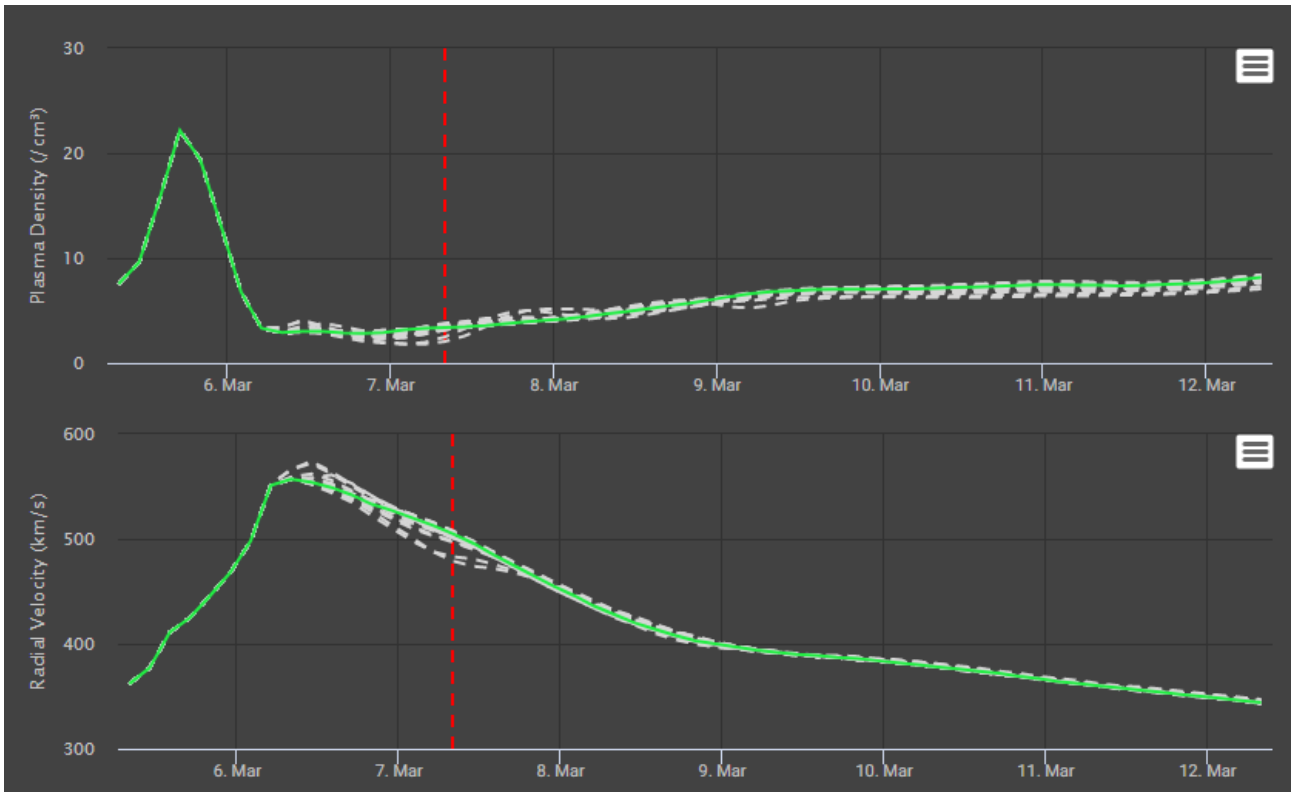
Figure 2:MOSWOC Enlil and ensemble, showing CMEs passing mostly ahead of Earth. Wind speeds are likely to slowly decline, perhaps more slowly than suggested by Enlil.





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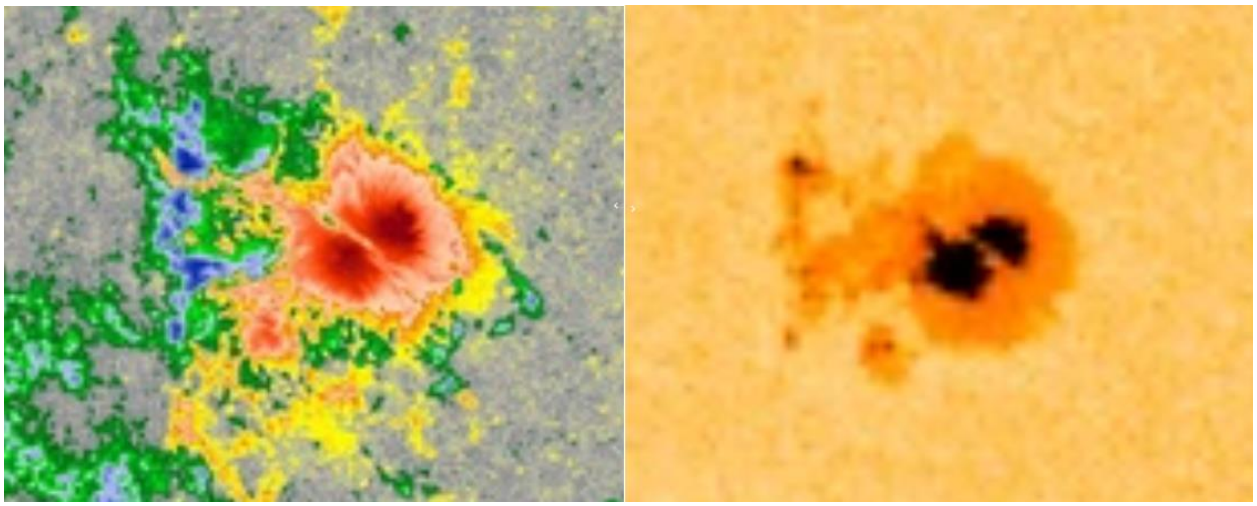
Radio Blackouts - X-Ray Flares:
There are now twelve sunspot regions on the visible disc. AR3242 (Esi/Beta-Gamma-Delta) in the northeast quadrant is one of the largest regions, with a delta spot in the centre of the group, but otherwise does not appear to be significantly complex. AR3245 (Dkc/Beta-Delta) is also now of interest having grown in the last 24 hours. The penumbra of the leading and trailing opposite polarity spots have now merged, giving it a delta region. AR3243 (Dai/Beta-Gamma) on the northwest limb has produced two flares in excess of the M5 level on 05 and 06 March, but the risk from this region decreases once it rotates off the disc during Day 2 (08 Mar). However, any loss off the west limb is likely to be balanced by further possible returning regions rotating onto the east limb, with risks kept stable through the period.

Solar activity is forecast to be mainly Low to Moderate, with a slight chance of isolated X-class flares throughout.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	60	60
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: SDO magnetogram and intensitygram showing AR3245 in the southeast, which has recently grown and developed more complexity.



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Solar Radiation Storms - (High Energy Protons):
High energy (greater than 10MeV) proton flux, as observed by GOES16, is currently at background levels. AR3234 is now well over the west limb, with its influence on the forecast now significantly reduced. Meanwhile, AR3242 is nearing centre disc posing an increasing risk of radiation storms with any larger flares, especially given the delta configuration. AR3243, nearing the northwest limb, was also responsible for two flares in excess of M5 level, so this is now contributing a small amount to the risk of a proton event. In addition, the recent development of AR3245 in the southeast means that there will now be a larger contribution from this region. Overall, the probabilities have been kept flat through the period with AR3242 and AR3245 forming the bulk of the risk.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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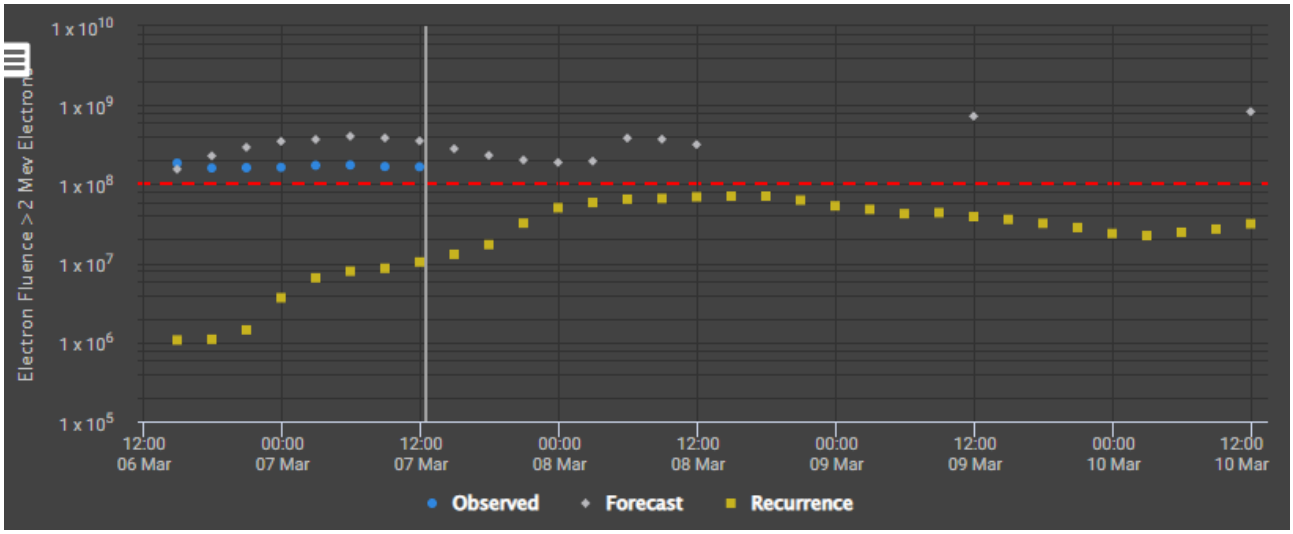
High Energy Electrons Event (≥ 2MeV):
Electron flux is at mostly high levels due to recent inputs from the coronal hole high speed stream. This is likely to remain above the high threshold through much of the period. However, any geomagnetic activity from a potential CME glancing blow or the onset of CH82 could reduce electron flux levels, but these are a low likelihood. There is also a risk of an increase in electron flux as the radiation belt is currently thought to be more significantly charged below GEO. As the high speed stream from coronal hole 81 eases and the radiation belt relaxes and expands, the electron populations at lower orbits could enhance the GEO electron counts, although the potential connection of coronal hole 82 on Days 2 or 3 (08-09 Mar) could inhibit this relaxation.

Electron fluence is expected to remain above the Active (1e8 integrated pfu) threshold, with a very slight risk of exceeding the Very Active threshold, although with a possible slow downward trend later in the period. MOSWOC REFM is forecasting an above Active trend through the coming three days, which seems reasonable.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	90	80	70
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	5	5	5

Figure 4: MOSWOC REFM showing an above Active trend for the next three days, which seems like reasonable guidance although with some uncertainty.



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